Apollo Belvedere

(GUEST EDITORIAL)

IT IS five years since the first human beings landed on another planet and then returned to earth. It is almost two years since the last Apollo mission returned to earth from the moon. The excitement of Apollo 11 which reached a large proportion of the population of planet earth is now a quiet, majestic fact in history. The excitement and interest in scientific aspects of all the Apollo missions is active and has grown into an evolving study of our sister planet.

Apollo probably represents the largest technical enterprise so far undertaken by our society. As such, it is difficult to fully comprehend or to discuss Apollo with either brevity or clarity. Our perspective is sometimes blurred by the rapidity with which both technological changes and scientific advances have occurred. On this fifth anniversary of Apollo 11, it is fitting to review what has passed, along with some personal observations.

The beginning of the 'Space Age' took place with the dramatic launching of Sputnik by the Soviet Union on October 4, 1957. The implications of this feat were manifest both in the military arena and in the civilian sector. The immediate effect of the launching of Sputnik was to cause intense self criticism within the United States and to goad the nation into some serious space-related activities. This permitted some of the talented staff associated with Wernher von Braun, then working for the U.S. Army at Huntsville, Alabama, to rapidly move ahead on the launching of a satellite–Explorer 1–on January 31, 1958. This 8.2 kg satellite contained James A. Van Allen's instrumentation which first detected the earth's trapped radiation belt.

The national introspection caused by Sputnik led to studies by different legislative bodies, and after intensive hearings of the Senate Preparedness and Investigation Subcommittee under the chairmanship of Lyndon B. Johnson, it was evident that a main consideration was to establish a civilian space agency. This led to the National Aeronautics and Space Act of 1958 which established NASA. This agency was charged with the responsibility of 'exercising control over aeronautical and space activities sponsored by the United States' excepting 'those activities peculiar to or primarily associated with the development of weapons systems, [and] military operations,' including military research. In particular NASA was charged to '(1) plan, direct, and conduct aeronautical and space activities; (2) arrange for participation by the scientific community in planning scientific measurements and observations to be made through use of aeronautical and space vehicles, and conduct or arrange for the conduct of such measurements and observations; and (3) provide for the widest practicable and appropriate dissemination of information concerning its activities and the results therof.' In addition, the administration was permitted to 'engage in a program of international cooperation.'

The newly formed agency began to formulate and initiate a variety of programs for the exploration of space. Probing of the lunar environment began with unmanned missions. In October 1959 the Soviet Luna 3 spacecraft gave us our first fuzzy view of the back side of the moon and showed it to be different from the familiar earth-facing side which has been scrutinized since Galileo. The cause of this lunar asymetry, so clearly shown by the later Lunar Orbiter flights, has given us a scientific problem that has not yet been adequately answered. The Ranger and Surveyor missions were then inaugurated by the United States to do scientific analyses by a series of well-instrumented hard and soft landings. In the meantime, the Soviet Union, through vigorous exploitation of a large payload capability, put Yuri A. Gagarin into space on April 12, 1961, to achieve a single earth orbit on Vostok 1. This was followed by a suborbital flight by Mercury astronaut Alan B. Shepard, Jr., on May 5, 1961.

President J.F. Kennedy addressed the Congress on May 25, 1961, in a special message titled 'Urgent National Needs' and stated,

> . . . I believe that this nation should commit itself to achieving the goal, before this decade is out, of landing a man on the moon and returning him safely to the earth. No single space project in this period will be more impressive to mankind, or more important for the long-range exploration of space; and none will be so difficult or expensive to accomplish. . . . But in a very real sense, it will not be one man going to the moon; if we make this judgment affirmatively, it will be an entire nation. For all of us must work to put him there.

He identified four major national goals for space. These were (1) landing a man on the moon and returning him safely to earth before this decade is out, (2) accelerating development of the Rover nuclear rocket, (3) accelerating the use of space satellites for worldwide communications, and (4) developing rapidly a satellite system for worldwide weather observations.

The first of these objectives was Apollo, and a 'race' to the moon was on, pioneered by unmanned space-

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Convention Manager, SEG, P.O. Box 3098, Tulsa, Okla. 74101.)

Summer **International Symposium on Solar Terrestrial Physics,** in Boulder, Colo. Sponsored by AGU. (AGU, 1707 L St., N.W., Washington, D.C. 20036.)

June 27–July 3 Fifteenth International Conference on Coastal Engineering, in Honolulu, Hawaii. Sponsored by American Society of Civil Engineers and the State of Hawaii. (J.T. O'Brien, Director, J.K.K. Look Laboratory of Oceanographic Engineering, University of Hawaii, Honolulu 96822.)

Aug. Metallogenesis in the Light of the New Global Tectonics, in Sydney, Australia. Sponsored by International Federation of Societies of Economic Geologists. (M. Solomon, Department of Geology, University of Tasmania, P.O. Box 252c, Hobart, Australia 7001.) [See March NEWS section.]

Aug. 16–25 Twenty-Fifth International Geological Congress, in Sydney, Australia. Sponsored by Australian Academy of Science, Geological Society of Australia, and International Union of Geological Sciences. (Secretary-General, International Geological Congress, P.O. Box 1892, Canberra City, ACT 2601, Australia.) [See March INTERNATIONAL GEOPHYSICS section.]

Sept. 13–24 **Joint Oceanographic Assembly Ocean World II,** in Edinburgh, Scotland. Sponsored by Scientific Committee on Oceanic Research, International Association of Physical Sciences of the Oceans, International Association of Biological Oceanography, Commission for Marine Geology, and Royal Society, U.K. (W.S. Wooster, Chairman, JOA Steering Committee, Rosenstiel School of Marine and Atmospheric Sciences, University of Miami, Miami, Fla. 33149.)

Oct. 23–28 Society of Exploration Geophysicists Forty-Sixth Annual International Meeting, at Albert Thomas Convention Center, Houston, Tex. (David Yowell, Convention Manager, SEG, P.O. Box 3098, Tulsa, Okla. 74101.

FUTURE AGU MEETINGS

Fall Annual Meeting

December 12–17, 1974
December 8–12, 1975
December 6–10, 1976
December 5–9, 1977
December 4–8, 1978

Annual Meeting

Fifty-Sixth, June 16–20, 1975
Fifty-Seventh, April 12–16, 1976
Fifty-Eighth, April 18–22, 1977
Fifty-Ninth, April 17–21, 1978
Sixtieth, April 16–20, 1979

Pacific Northwest Region

Twenty-First, October 17–18, 1974

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craft. Ranger and Surveyor became Apollo support and Lunar Orbiter paved the way for a manned landing. Chemical analyses of the lunar surface were first carried out with the α-scattering experiment of Anthony L. Turkevich on Surveyors 5, 6, and 7 between September 1967 and February 1968. These experiments provided limited but clear results in both a qualitative and a quantitative sense. The broader meanings and acceptance of these results had to await the very hard data from Apollo, but the basic information was there and ready for interpretation.

The manned flight program was moving ahead with an outstanding record of successful Gemini missions and with three consecutive successful unmanned Saturn I-B launches through 1966. However, the program suffered a major catastrophe when three astronauts died in a disastrous fire during a launch pad test at Kennedy Space Center on January 27, 1967. After an exhaustive and thorough investigation, NASA instituted extensive changes in management, operating procedures, and equipment to ensure that such a catastrophe would not be repeated. The increase in costs that resulted from these anticipated changes caused major fiscal constrictions on other space activities, particularly in the area of unmanned planetary exploration.

The subsequent period was one of extreme diligence, care, and pressure. The work toward a lunar landing proceeded. Twenty months later on October 11, 1968, the first manned mission in the lunar landing program made a successful flight. Apollo 7 flew and 11-day mission of 163 earth orbits. A few months later, with a carefully calculated risk, Apollo 8 was launched to the moon. On December 24, 1968, the spacecraft orbited the moon, and Frank Borman, James A. Lovell, Jr., and Willam A. Anders became the first men to see the moon's far side and to view earth rise from the near vicinity of another planet. The procedures of maneuvering and docking were tested and exercised in earth orbit with Apollo 9, and finally, with Apollo 10, men returned to lunar orbit and exercised the descent procedures utilizing the LM. They approached to within 9 miles of the lunar surface and then returned. This gave the final measure of confidence to proceed to the first manned landing.

On July 16, 1969, Apollo 11 was launched and on July 20, while Michael Collins remained in orbit, the message came: 'Houston, Tranquillity Base here, the Eagle has landed.' Neil A. Armstrong and Edwin E. Aldrin, Jr., became the first men to land on another planet. This signal came from a distance of 1.3 light seconds—a separation that is cosmically very small and humanly enormous. Apollo 11 brushed the old cobwebs of mythology away with the rudeness of a new generation of Argonauts. The mythologic allusions which are present in every earth language were made archaic and strange by real men on a real moon. A human-faced disk jumped over by cows, populated with moon maidens of various races, rabbits, or a woodsman has become incongruous with the reality of Apollo and has yielded to a new myth of the infinite extendability of mankind.

The crew of Apollo 11 returned safely to earth on July 24, 1969, in the Columbia service module. The time from the scare and challenge of Sputnik to the success and dignity of Apollo 11 was just a dozen years. The goal established by J.F. Kennedy and the Congress was achieved before the decade was out. The subsequent Apollo missions extended the stay time on the lunar surface, and the flexibility of action increased with the rising confidence of NASA management and the flight crews. The science content of the missions mostly revolved about the ALSEP (Apollo Lunar Science Experiment Package).

Because Apollo 11 and Apollo 12 were such perfect flights, the world at large actually began to believe that manned space flight was, after all, not very special. Major technical achievements had come so rapidly that in the new era, which was only two missions old, success was almost accepted as a straightforward accomplishment. Apollo 13 proved to be an exception. The motto of the mission was 'Ex Luna Scientia,' but the bursting of an oxygen tank and subsequent serious loss of power aborted the moon-landing mission. The human and technical drama that ensued was in its own right one of the most remarkable feats in all of manned space flight. The lifesaving operation between planet earth and the three cool-headed, moon-bound astronauts James A. Lovell, Jr., Fred W. Haise, Jr., and Thomas K. Mattingly II made the best of science fiction stories pale by comparison. The unfolded LM served as a space life boat, and through the communal ingenuity and systems expertise of the people on earth and the people out there, the spacecraft Odyssey was brought safely back to splash down on earth. The overall impression is of the whole earth acting as a single complex organism, extending a tendril out into distant space, and feeling it injured, safely withdrawing it.

Cautious optimism was regained on Apollo 14, which visited the Fra Mauro area—a non-mare region that contained debris from the huge Imbrium impact. The remaining missions Apollo 15, 16, and 17 were of the advanced J series type and provided greatly increased mobility on the lunar surface by use of the Lunar Roving Vehicle (LRV). Confidence in the performance of both crews and equipment greatly enhanced the science content of these expeditions. As distinct from the earlier missions, there was some flexibility in the Extra Vehicular Activities (EVA), and some new science procedures were inaugurated which had not been hard-wired into 'the system' from the beginning. The last crew of Apollo consisted of Eugene A. Cernan, Harrison H. Schmitt, and Ronald E. Evans, who landed in the Taurus-Littrow valley and returned to earth on December 19, 1972. In a recent meeting in Moscow, there was considerable surprise on the part of some of the Soviet delegates that Schmitt was actually a scientist.

The time interval between Sputnik and termination of the Apollo missions was 13 years. The 'race' to the moon was over. The cost was large but the technical and human accomplishments were larger. The total cost to the United States was about \$17 per person per mission—all of which was spent here on earth.

We have primarily given a very brief historical outline of flight events and have placed little emphasis on the science that was accomplished. The chief national goal as enunciated by J.F. Kennedy was the manned landing, with the safety of the crew assured. Purely scientific goals were not a prime moving force, which unfortunately led to a strained relationship between the scientific community and NASA. Scientific objectives were of necessity secondary, and in actuality they were subject to the severe 'man qualified' constraint. Purely flight hardware experiments required enormous investments of time and energy by principal investigators in order to interface them with 'the system' and flight qualify; changes in EVA time lines to obtain scientific data were very difficult to achieve.

Recognition of the importance of science objectives increased as the missions matured, but the flexibility of 'the system' to include new concepts and functions was limited. This was undoubtedly due to the deep feeling by NASA management for the safety of the flight crews, but such a philosophy also hindered scientific inovations responding to the discovery of the earlier missions. This aspect of Apollo history must be placed in its proper context to serve as a valuable guide in future enterprises.

The excitement and importance of scientific discovery, although not a primary objective, was still a highly significant part of the Apollo missions. The Apollo flight packages included a number of excellent orbital and landed experiments. The glittering grey-black basalts returned by Apollo 11 made obvious the enormous value of the returned lunar samples. The overall scientific results were of high quality. This surprised and pleased many scholars who were unaware of the rich results inherent in planetary exploration. New discoveries and concepts were born and many old scientific fables evaporated. The pre-Apollo speculations on planetary evolution vanished in the light of the new data, and a new generation of scientific speculation is now upon us. The difference is that the fairy castles are constrained by substantial scientific fact. The rate of increase in knowledge over the period of the Apollo missions was exceedingly rapid and caused complex changes in both observation and thought, so that our perspective is sometimes lacking. We have taken a quantum jump in our views of planetary evolution because of Apollo, and it is difficult to remember our earlier gropings.

Well before the Apollo missions drew to a close it was clear, in certain circles in the NASA administration and in the scientific community, that the flight program and the science program were different. When the flight program was over, there still remained the great problems of ALSEP data acquisition and evaluation, the study both of the reduced data and of the lunar samples, the synthesis of these data, and the preservation of these treasures for future generations.

Even though NASA is preeminantly committed to flight programs, the NASA charter has a specific commitment to space science. It was (and is) thus necessary to recognize the importance of reaping the scientific fruits of all flight missions by supporting a prolonged, but not indefinite, phase of postmission study. The high-compression operation of science during the period of Apollo flights must be followed by a long-term period in which a mature product of high scientific quality will be produced. New data will have to be obtained, the old incomplete data filtered, and new approaches identified. This function of Apollo science is currently vital and active. The knowledge obtained by the international scientific community which participates in this vigorous and cosmopolitan endeavor will undoubtedly play a key role in future planetary exploration.

Concomittant with the extended postmission study, it is most reasonable that NASA should formally assume its rightful responsibility for maintaining the lunar samples in as pristine a condition as possible for study by present and future generations, and for providing the means to make these materials available to scholars.

Of the four goals identified by President Kennedy in 1961, three are now realized (only the nuclear rocket has fizzled). Apollo was a resounding success, the international use of satellites for worldwide communication has developed rapidly, and the use of satellite systems for worldwide weather observations is now established.

In addition, since 1970 there has been a wider exploration of the solar system using unmanned space vehicles. Two lunar sample return missions by the Soviet Union gave valuable supplemental data to that obtained by Apollo. Our first hard look at Mars, Jupiter, Mercury, and Venus were achieved by both American and Soviet spacecraft. The recent Jupiter and Mercury encounters represent significant scientific advances. These missions comprise a start toward the broader goal of the exploration of the planets and space astronomy, which were identified as the primary objectives by both PSAC (the President's Scientific Advisory Committee) and the Space Science Board for the U.S. Space Program in the post-apollo period. The role of man in general planetary exploration remains undefined, and the question of whether man will maintain his toehold in space is largely unanswered. It is clear that the major scientific exploration of the solar system outside the immediate vicinity of earth must for the present be carried out with unmanned systems of orbiters, landers, probes, and sample return.

We learned from Apollo that it will be necessary to emphasize the scientific planning as indicated in the franchise of NASA in order that the scientific content of all space missions be optimized. Adequate scientific management must become an intrinsic part of all stages in large-scale technical endeavors. This participation should begin with the definition of the mission itself and continue on an interactive, discursive basis into the mission and beyond to the final evaluation. The scientific community must also be willing and able to participate in the planning and engineering as well as the decision-making functions. This will take a great deal of time on the part of the general scientific community.

In its evolution, the U.S. Space Program has produced truly significant scientific discoveries and has demonstrated the practical uses of satellites. The efforts which led to the success of the Apollo program were not a national burden but a general stimulant to the national spirit and indeed to the spirit of all mankind. The true price of Apollo is measured not in dollars but in national effort. With this effort we have purchased a historical eminence that transcends national boundaries. There is no doubt that Apollo stands on this eminence and commands a fine view.

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